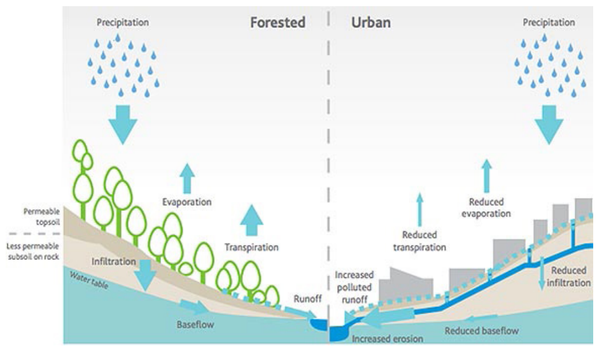
Urban Stormwater as a Resource; Possibilities for a new public space in Clemson University

Stormwater runoff :
Precipitation of rain and snow that flows over land, doesn't percolate into the ground.



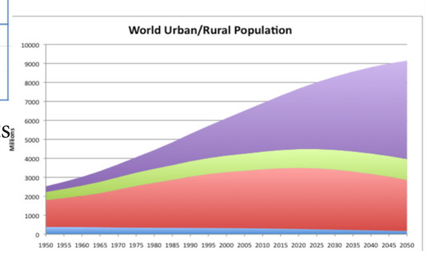
Collects pollutants
Discharges to surface water bodies

Five times more runoff
Variety and amount of pollutants

Rivers and Streams	Lakes, Ponds, Reservoirs	Estuaries
Agriculture	Agriculture	Municipal Point Sources
Hydro modification	Hydro modification	Urban Runoff/Storm Sewer
Urban Runoff/Storm Sewer	Urban Runoff/Storm Sewer	Atmospheric Deposition

"The most recent National Water Quality Inventory reports that runoff from urbanized areas is the leading source of water quality impairments to surveyed estuaries and the third-largest source of impairments to surveyed lakes."

by 2020 more than 60% of world's population live in urban areas



At least 25% of world's population will face freshwater scarcity by 2050.

Global consumption of water has been doubling every 20 years, more than twice the rate of human population growth.

Problem Statement

Stormwater as a liability
Dispose of untreated stormwater into the surface waters
Focus on infiltrating
Extraction from aquifer
Most cases designed for the flood issue not people
Water scarcity issue

Hypothesis

Catch the rainwater before it runs through city
Treat on site
Use it for creating public places to raise awareness
Use it as water resource

EPA
six steps of "stormwater best management practices":

1. Public education
2. Public involvement
3. Illicit discharge detection and elimination
4. Construction
5. Post-construction and
6. Pollution prevention

Urban Stromwater - Pollution and Flooding

Low-Impact Development - maintaining site's natural hydrology

Green infrastructure - mimics nature by soaking up and storing stormwater.

Literature Review

Rainwater Harvesting

Capture and use of rainwater as fresh water supply

Ancient practice
Scarce sources

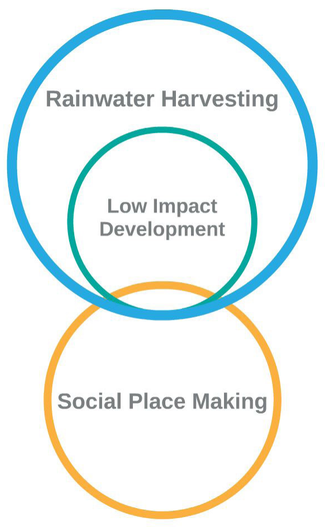
Western United States
Water conservation

1. Passive Rainwater Harvesting
Volume - small (50-100 gallon)
Catchment - rooftops
End-Use: untreated - outdoor purposes, irrigation, carwashes
Storage: on grade
Water Extraction: spigots, no connection to internal or external plumbing

2. Active Rainwater Harvesting
Volume - large (1,000 – 100,000 gallon)
Catchment - any surface with runoff
End-Use - to be treated for any end use
Storage - under or above grade
Water Extraction - pumping, elevation change, connected to internal or external plumbing

Steps of stomwater harvesting:

1. Collection
2. Treatment
3. Storage
4. End-use



Collection

Collection system directs stormwater from catchment area to storage or treatment area.

Traditional - gutters, pipes and channels
Natural stormwater management practices

Quality of captured water

Type of material it has run through
Climatic condition
Surrounding environment

First Flush:
Debris - clog the collection system - filters
Smaller contaminants - stored or directed separately

Divert one to two gallons of first-flush for each 100 square feet of collection area

Treatment

Major obstacle in use of stromwater as a resource is, lack of reliable and affordable treatment system considering the public health.
Practices:
United States
Georgia, North Carolina, Texas and Virginia
Municipalities:
Los Angeles, San Francisco, Tucson and Portland
non-natural treatments:
sedimentation, chemical treatments, ultraviolet, ozone treatment, reverse osmosis and etc.
Natural treatment can achieve the required quality for many uses.
Australia
Natural elements for upstream water treatment before the advanced treatment system.
BMP
Small lot
Each practice - a separate function
Engineering

LID
Connects BMP facilities in a distributed network
All parts provide a level of water treatment
Planning

Advanced Treatment:

Pathogenic organisms:
membrane filtration
conventional media filtration
reverse osmosis
membrane bio-reactor
electrodialysis
biologically activated carbon filtration
ultrasound
dissolved air flotation
ion exchange
distillation
high rate clarification
biological nutrient removal

Disinfection:
chlorination
ultra violet radiation
oxidation process
membrane filtration

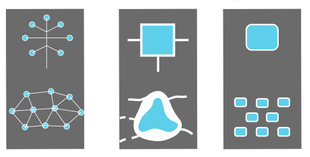
LID

Design based on hydrology
LID Principals

Redundancy
Distributed network of facilities
Multiple routs connection

Resiliency
Multiple facilities
Biological diversity
Maximum interfaces

Distribution
Optimize site's carrying capacity
Different facilities dispersed on site



Steps in selecting proper facilities:
1. Defining site's opportunities and constrains
2. Defining type of hydrological controls required
3. Final configuration

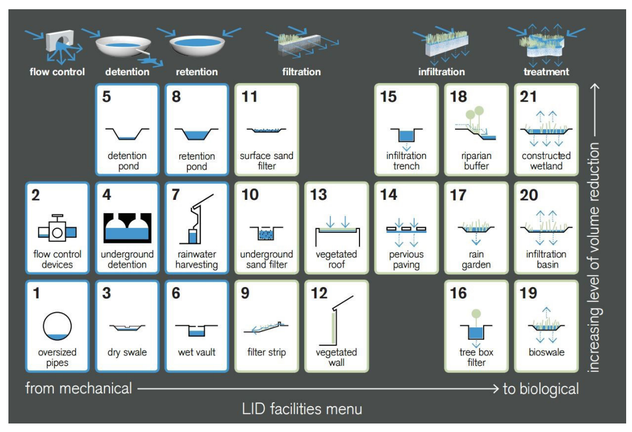
LID facility functions

1. Physical Process
Rely on hydraulic properties of water
Flow velocity, pre-treatment
Swale, buffer strips open water bodies

2. Infiltration
Porous and permeable pavement, infiltration basin and trenches, sand filters and biological engineered soils

3. Biofilteration
Physical and biological process to treat
Soil and vegetation
Collected through pipes
Best media sand or sandy-loam soil
wetland

4. Proprietary Devices
Gross pollutant, oil and grease, and sediment trap devices are commonly used at the beginning of treatment to remove fine sediments.



Storage

Storage can serve purposes of water supply, flood mitigation, recreational amenity, aesthetic amenity, water quality improvement, habitat provision and firefighting supplies
Types of storage:

Tanks
Minimum water loss
Expensive installation
Algal bloom in sunlight exposure
Smaller catchment area

Aquifer
Large catchment

Open storage
water loss
human contact issue
aesthetics challenge
Disinfection with UV light
Algal bloom if long detention and lack of nutrient removal
Attraction of bird and mosquito

Public Perspective

Crucial to success of a project

Income and education
Knowledge of urban water, water quality
Frequency and severity of potable water restrictions
Familiarity with alternative water sources
Assurance of health risks
Advocacy of authorities, government agencies and researchers
Characteristics of each project like end use of water, cost of water supply, degree of contact with water in a project and environmental values.

Opposition is common when a new concept is introduced, but education of the public can increase their trust and bring support.

Garden irrigation 96%, Toilet flushing 95%, Laundry purposes 68%, Personal washing 50%, Potable uses 29%.

Social Place Making

Promenade

Place for social life.Need in mixing with other people..Gathering places in frequent intervals. Right size. Forms activity nodes, along its length

Activity nodes

Essential in generating neighborhoods..Connection to main paths. Small enough- concentrated activity. Symbiotic relationship of surrounding facilities.
Small public square
Activity node. Promenade. Size. Diameter of 60 feet (general rule)

Streets and paths

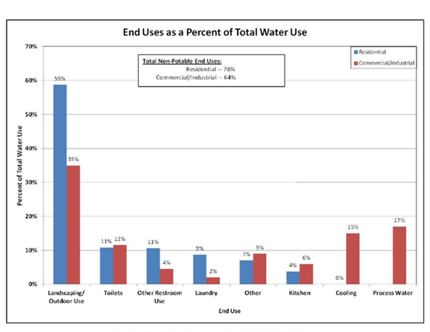
Place for being in public. Support diverse activities. Delicate balance between "being defined and yet not too defined". Outdoor room designed unfinished, to be finished by activities people would bring to it.

Water

Natural state of land and streams
Boundaries can be formed
More human places
Quite refuge
Psychological effect on humans

End-Use

No federal regulations and standards for rainwater harvesting with non-potable uses.
States or local governors have regulations and policies which varies from one location to another.
End use of stormwater:
1. Potable
2. Non-potable
toilet flushing
garden watering
car washing
industrial uses
ornamental water features
firefighting
environmental flow provision
groundwater recharge.



1 – Residential end uses based on AWWA (1999).
2 – Commercial/Industrial end uses based on Pacific Institute (2003).

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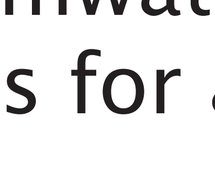
Methodology

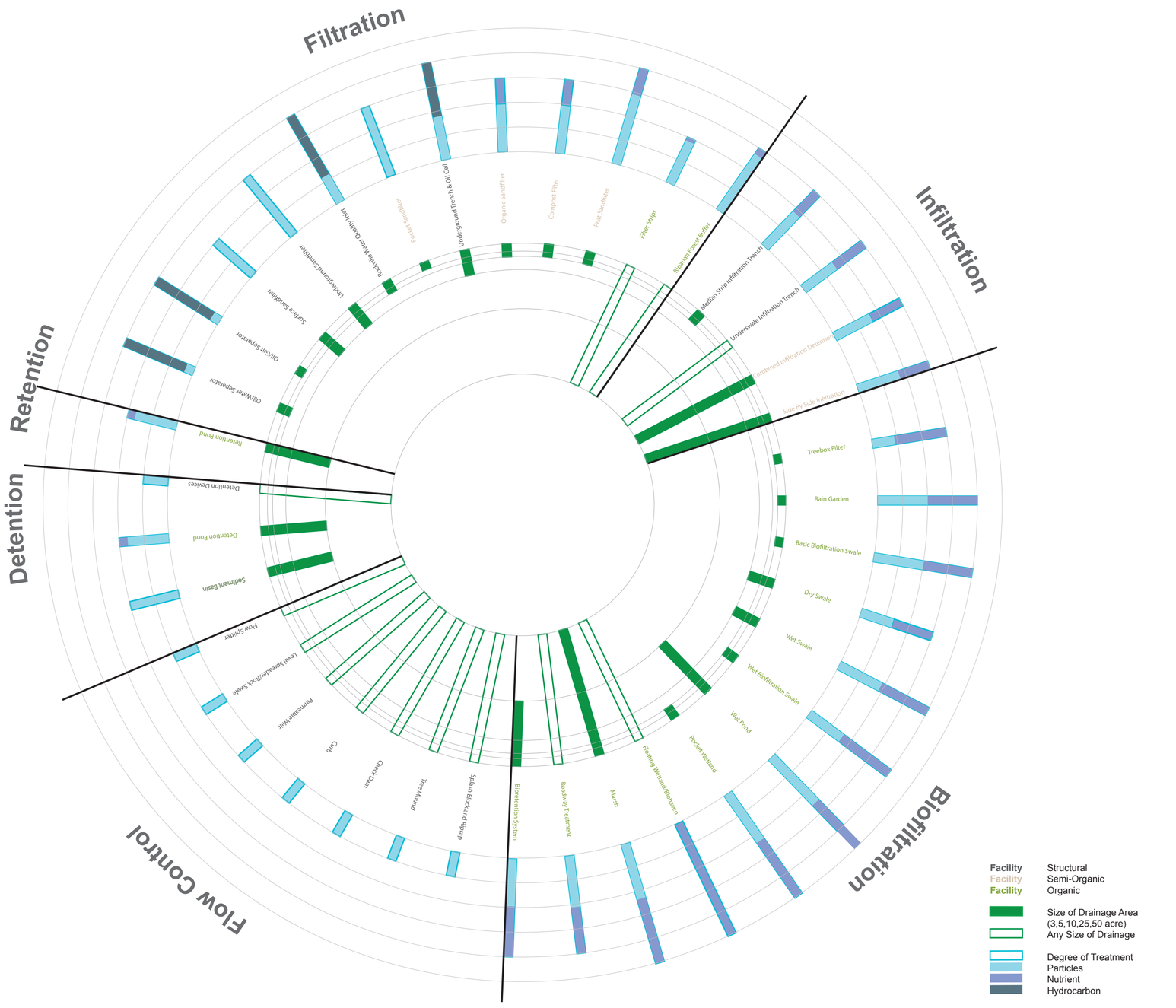
Data Analysis

Case Study

Review of relevant literature has created a basic guideline on approaching a stormwater reuse project, but there remains two main information gaps in fulfilling the goal of the research. The first gap is the information on designing a public space with the stormwater reuse facility. For this matter some of the best projects in creating public space within stormwater reuse/treatment, was studied. Second gap is the information about the treatment of water. Although there are many guidelines on the use of stormwater management facilities with LID principals and there exist documents on the characteristics of each facility. But no comprehensive guideline were found on the treatment process of water or best facility for achieving specific quality of water (pollutant). For this matter the researcher has gathered information about each facility and has categorized them based on the type of treatment, drainage size, degree of treatment and the type of contaminant treated.
The studied cases are as follows:

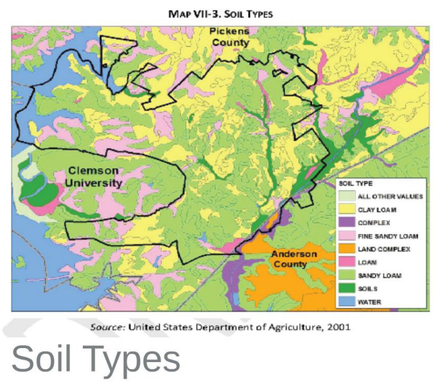
Availability of water
Changing amount of water
Natural and urbanized areas
Active places designed for leisure
Serene, calm places for pleasure, relaxation or learning
Interaction with water can be defined as visual, touch and hearing
These experiences any part of the process, the conveyance, treatment or storage

					
Name	Sidwell School	Thornton Creek	The Ave	Water Square	Rancho Viejo
Location	Tenleytown Washington D.C	Seattle WA	Washington D.C.	Rotterdam Netherlands	Santa Fe New Mexico
Water Source	Waste Water	Urban Runoff	Rooftop	Rooftop	Greywater
Collection	Pipeline	Pipeline	Pipeline	Pipeline	Swale
Treatment	Filtration Wetland Ultraviolet	Aeration Swale Sediment Pool Wet-bioswale	Sedimentation Biohaven Detention	Sedimentation	Swale Detention Basin
Storage	Wetland	Creek	Underground Tank	River	Aquifer
End-use	Toilet Cooling Tower	-	Irrigation	-	Irrigation
Public Amenity	Nature Pond	Nature Pond Sound of Water	Water feature Pond	Leisure Vanishing Pond Sound of Water	Nature



Site Selection

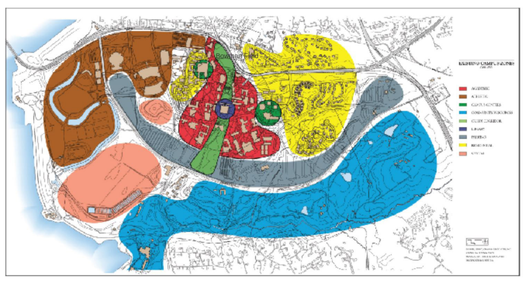
Major drivers for selection of the site were proximity for site visits and an urbanized area. It is know that a university campus has to support all the community activities as a city, hence the design of a campus is like the design of an urban area. The Clemson University campus was selected as the campus. Further analysis and studies of the campus has led to several possibilities for development on campus. Among the choices the one with more similarities to a dense urban context was selected, the underdeveloped area located on Campus Green, the backyard of the main library. This area being in the core of the campus is a valuable choice for the purpose of raising the public awareness about the water conservation issues.



Soil Types

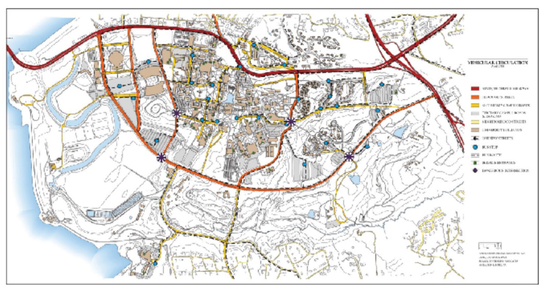
Land Use

Campus Property

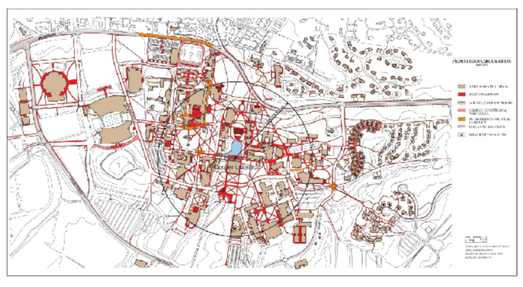


Zoning

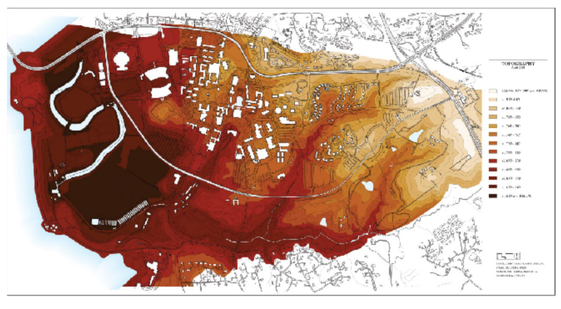
Open Space



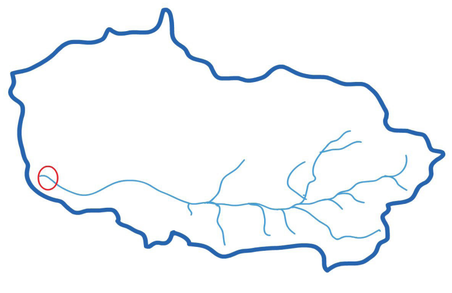
Vehicular Circulation



Pedestrian Circulation

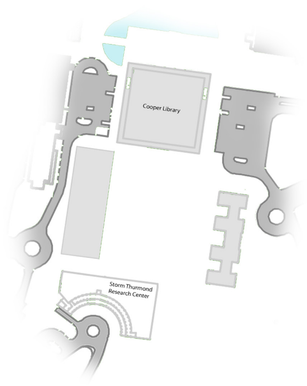


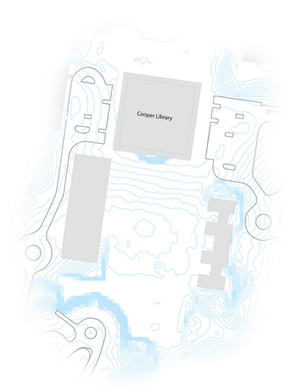
Campus Topography

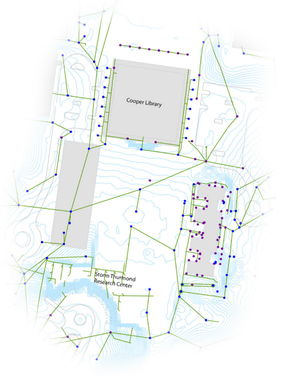


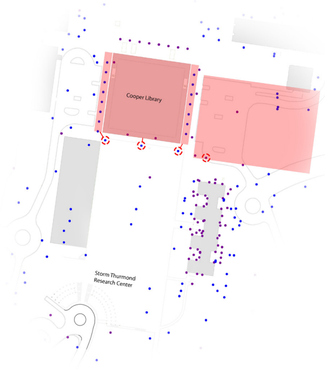
Hunnicut Creek

Site Analysis

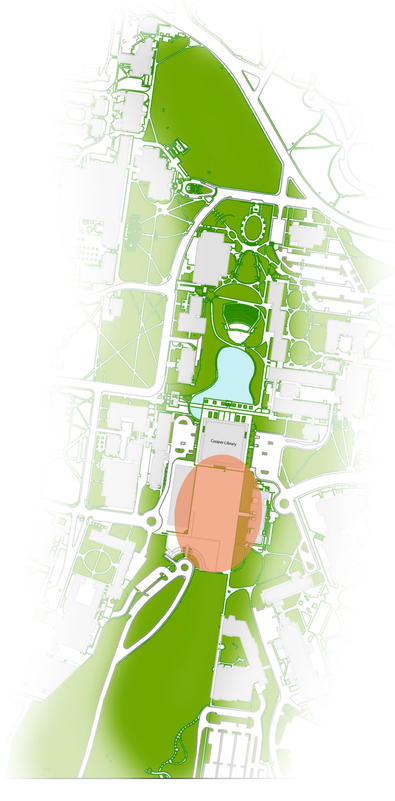








Project Site



Water Budget

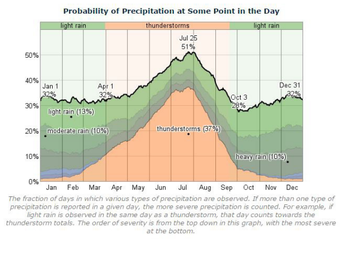
SCDNR: Highest level of precipitation in 100 years, for Pickens county 3.98 in/h

Q=CiA

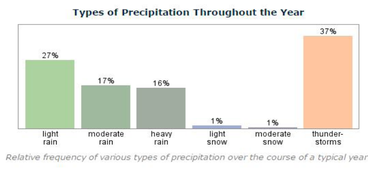
Peak Runoff = Dimensionless coefficient * rainfall intensity * Area of drainage

Asphalt C: 0.85
Grassland C: 0.3
Roof surface C: 0.9

Rooftop: 4.3 ft3/s
Asphalt: 2.03 ft3/s
Grassland: 1 ft3/s



The fraction of days in which various types of precipitation are observed. If more than one type of precipitation is reported in a given day, the more severe precipitation is counted. For example, if light rain is observed in the same day as a thunderstorm, that day counts towards the thunderstorm totals. The order of severity is from the top down in this graph, with the most severe at the bottom.



Relative frequency of various types of precipitation over the course of a typical year.

BLUE HABITAT

Thesis Research and Project
Advisor : Dr.Schurch
Sheida Moin - Spring 2015